



COMPARATIVE STUDY ON BIOGAS PRODUCTION FROM COW DUNG, FOOD WASTE AND ORGANIC WASTES

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ABSTRACT

Anaerobic digestion is one of the ecofriendly methods to treat and dispose the biodegradable wastes and has more advantages when compared to any other waste treatment methods. Biogas production and composting of slurry from the biogas plant is one of the methods to reduce volume of waste (zero waste discharge) and maximum energy recovery from the organic wastes is possible.

In this study the production potential of biogas from bio degradable organic wastes such as food waste, cow dung and fresh organic wastes under the same operating condition of room temperature between 28°C to 32°C are compared. A pilot plant of 0.3 cubic meter gas holding capacity is used as digester.

Key words: anaerobic digestion, biogas, composting, cow dung, food waste

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1. INTRODUCTION

At present environment is getting affected by numerous pollutants that pollute land, water, atmosphere and environment. For controlling the pollution, various measures are taken now a days. More research is being carried out to identify the method to reduce the rate of pollution and controlling the pollutants. Solid waste management is one of the major challenges faced by many countries around the world. The Integrated Solid Waste Management system is a comprehensive waste prevention, recycling, composting and disposal program. It is based on the concept of reduce, reuse and recycling of wastes.

Solid waste is generated by human activities. Household garbage, leftovers of food and other wastage that include old house hold items such as papers, plastic wastes, parts of machineries or any other products that are consumed during every day activities are some forms of solid wastes. Solid wastes are generated from the beginning of human civilization. Early men consumed animal products and generated garbage in the form of bones and other parts of animal slaughtered.

Population growth, modernization, and increasing industrial activities generate considerable amount of different types of wastes from the production process. These wastes are in the forms of solid, semisolid, degradable, non-degradable and hazardous wastes leading to atmospheric and environmental pollution.

1.1. Effects of Solid Waste

In practice different methods are used for the disposal of solid wastes. The selection of disposal methods are based on the factors like characteristics of waste, quantity of waste generated, land availability, economical consideration etc.

Improper disposal of wastes lead to pollution. Populations in some areas where there is no proper treatment method or living very close to waste dump yard are under high risk due to micro-organisms in the waste. If there is no proper handling, storage and disposal of wastes, that leads to movement of leach ate and pollute soil and ground water. They create an environmental problem like spreading diseases, breeding various types of insect and infectious organisms and foul odour.

1.2. Sources of Solid Wastes

Residential areas, Markets, Parks, Public places, Bus & Railway stations, Industries, Commercial places, Educational Institutions, Construction activities and Agricultural services are the major sources of solid wastes. The waste generated such as food waste, paper, cardboard, plastics, textiles, leather, yard waste, wood, glass, metals, ashes, special waste (e.g., bulky items, consumer electronics, white goods, batteries, oil, tires), and household hazardous waste, construction and demolition materials.

1.3. Solid Waste Disposal methods

- Sanitary Landfill
- Incineration
- Pyrolysis
- Composting
- Biogas production (anaerobic digestion)

Among the above disposal methods, anaerobic digestion is the method to achieve two goals both of energy recovery and sanitary disposal of biomass (biogas production and high nutrient manure). Since, anaerobic method does not produce leachate, odour, spread diseases, air pollution which are compared with pyrolysis and incineration methods. Biogas is one of the best available sources to fulfill the energy demand in the rural areas.

1.4. Advantages of Biogas

- Biogas is to be considered a renewable source of energy.
- Biogas plants are easy to set up and require minimum capital investment on a small scale basis.
- Biogas is a modern source of energy for cooking and lighting.
- Biogas has a positive influence on both climate change and the environment.
- Cheaper Technology because it can be used to produce electricity and heating purpose.

- Cooking on biogas is faster and easier than cooking on charcoal or firewood.
- Easy to produce organic fertilizer.
- It reduces the greenhouse effect.
- It is to be considered non-polluting in nature.
- Reduces Landfills, hence, decreased soil and water pollution.
- Reduce cooking fuel expenses by as much as 90%.
- Reduce household waste.
- The use of biogas slows down deforestation and reduces greenhouse gas emissions.
- Job opportunities are created in these plants.
- Due to uniform distribution of thermal efficiency is higher.

1.5. Disadvantages of Biogas

- It is very difficult to enhance the efficiency of biogas systems.
- Biogas contains some gases as impurities, which are corrosive to the metal parts of internal combustion engines.
- Generation of biogas is governed by temperature. Hence, it is not suitable for cold regions.

Table: 1 Typical Composition of Biogas

COMPONENT	CONCENTRATION (BY VOLUME) in %
Methane (CH ₄)	55-60
Carbon dioxide (CO ₂)	35-40
Water (H ₂ O)	2-7
Hydrogen sulphide(H ₂ S)	2
Ammonia (NH ₃)	0-0.05
Nitrogen (N)	0-2
Oxygen (O ₂)	0-2
Hydrogen (H)	0-1

1.6. Characteristics of Biogas

Composition of biogas depends upon feed material. Biogas is an odorless and colorless gas that burns with blue flame similar to LPG gas. Biogas is about 20% lighter than air has an ignition temperature in range of 650°C to 750°C. Its calorific value is 20 Mega Joules (MJ) /m³ and it usually burns with 60% efficiency in a conventional biogas stove.

This gas is useful as fuel to substitute firewood, cow-dung, petrol, LPG, diesel, and electricity, depending on the nature of the task, and local supply conditions and constraints.

1.7. Anaerobic Digestion

Anaerobic digestion (AD) is microbial decomposition of organic matter into methane, carbon dioxide, inorganic nutrients and compost in oxygen depleted environment and presence of the hydrogen gas. This process also known as bio-methanogenesis, occurs naturally in wetlands, rice fields, intestines of

animals, manures and aquatic sediments and also it is responsible for the carbon cycle in the ecosystem. Major natural sources of methane are the wetlands and animal guts while the main anthropogenic sources have been identified in the fossil fuel processing industries, rice fields and landfills.

Biological activity has been identified the cause for more than 80% of the flux of the atmospheric methane (Palmisano et al. 1996).

In general there are three different methanogenic ecosystems in the nature.

- In lacustrine and marine sediments, marshes, swamps, rice soils, sludge and digesters where the organic matter is completely degraded.
- In ruminants and intestinal tracts of almost all living creatures (e.g. humans, insects, termites), where the process of mineralization is incomplete and most of the intermediate products (e.g. volatile fatty acids) are absorbed into the bloodstream.

1.8. Factors Affecting Anaerobic Digestion

- Temperature
- Pressure
- Retention time
- pH
- Solid Material concentration
- Loading rate
- Water content

2. EXPERIMENTAL STUDY

In this experimental study a pilot plant which is made up of synthetic tarpaulin material and having a dimension of 2'3'' x 2'3'' x 4'5'' was used.

Six hundred liters of cow dung slurry (1:1) is poured in to the plant. Then 50 liter of biogas plant slurry is added with it as a starter for bacteria which are producing biogas. The total study is under room temperature ranges 28⁰C to 32⁰C.



Figure 1 (a, b) –Bio gas Pilot Plant

After 20days the biogas was generated, the volume of production for first time is 0.3m^3 with time duration of three days.

In trial-1 to trial -4, 12liters of cow dung slurry is added in to the plant. The gas production rate is observed and tabulated.

After completion of the study on cow dung, the same setup is used on food waste.



Figure 2 Slury of food waste

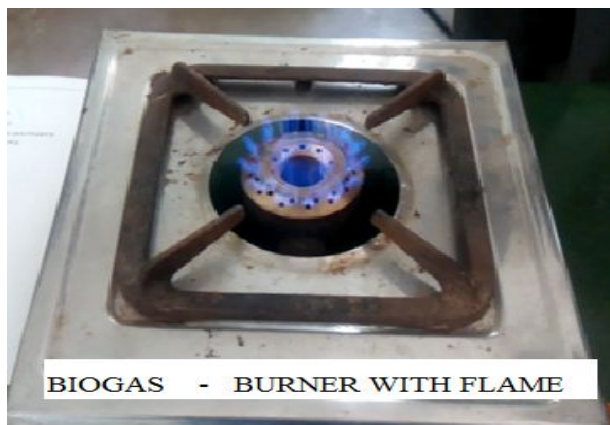


Figure 3 Burning test

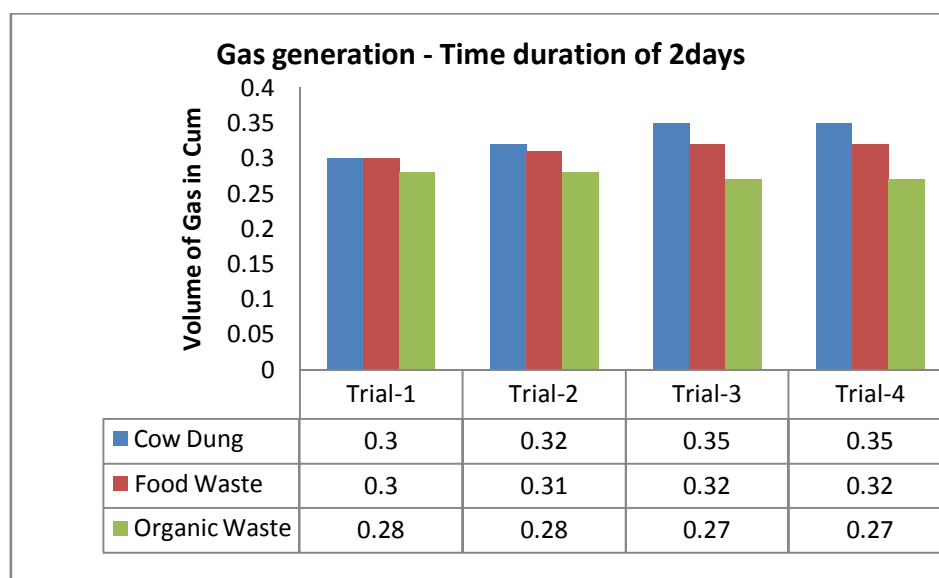
Four trials of 12liters of well crushed food waste slurry is added into the plant and gas production rate is observed. Cooked waste rice is used for this study.

After two days of the above studies, it was observed that there was no generation of biogas inside the digester, Six kilogram of crushed fresh leaves were added with six liters of water are poured into digester. Gas generation started from next day and the maximum volume got stabilized on third day onwards. The volume of gas generation was observed for continuous four trials.

Burning test was also conducted and average burning time of gas from cow dung was 70 minutes, food waste was 67 minutes and fresh organic waste was 60minutes. The average boiling time of one liter of water under this study was 16 minutes.

Table 2 Gas Generation Data's

Sl. No.	Type of Waste	Volume of Gas Generated (in Cubic meter)			
		Trial-1	Trial-2	Trial-3	Trial-4
1	Cow Dung	0.3	0.32	0.35	0.35
2	Food Waste	0.3	0.31	0.32	0.32
3	Organic Waste	0.28	0.28	0.27	0.27

**Figure 4** Gas Generation Data's

3. RESULT AND DISCUSSION

From this experimental study the following results were obtained. Cow dung produced 0.35m^3 of biogas, Food waste produced 0.32m^3 of biogas and Fresh Organic waste produced 0.27m^3 of biogas. The entire study was conducted under same operating condition of room temperature without sunlight. The volume of Biogas generated was less compared with the past studies conducted under sunlight (out door). Hence, this result proves that temperature is a major factor which influences the generation of Biogas.

4. CONCLUSION

We conclude that the biogas generation from cow dung and food waste is nearly same. Installing biogas plants in places like educational institutions, residential areas, hotels, etc reduces the usage of LPG or any other fuels and also the problem of disposal of solid waste will be considerably reduced and hence pollution can be controlled. This is one of the ways to keep our environment Eco friendly.

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